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Pistillate flower abscission in Persian walnut (*Juglans regia* L.) under mild winter climates of Himachal Pradesh

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Abstract

Persian walnuts exhibit a unique phenomenon of pistillate flower abscission (PFA) which adversely affects the nut yield. In order to ascertain the extent of PFA and factors causing it under mild winter climates, a study on 13 indigenous selections and 7 exotic cultivars was undertaken. The experiments were conducted during 1999 and 2000 to determine degree of PFA in various cultivars/ selections under different modes of pollination. Per cent pistillate flower abscission in the first year varied from as low as 12.40 to as high as 100.00 under natural pollination, 8.47 to 62.36 under self pollination and 12.33 to 100.00 under cross pollination whereas in the following year the corresponding percentage varied from 13.22 to 97.66, 9.11 to 60.40 and 13.50 to 96.67, respectively. In unpollinated flowers, PFA (%) ranged between zero to 100.00% and 5.33 to 94.33% in 1999 and 2000, respectively. Mean values were 45.11, 25.75 and 27.21%, respectively. Our results indicate no clear trend towards this economically important phenomenon and suggest that PFA is neither exactly due to genetical differences nor it is entirely due to mode of pollination.

Key words: Pistillate flower abscission, Persian walnut, *Juglans regia*

Introduction

Pistillate flower abscission (PFA) is a common phenomenon in the Persian walnut (*Juglans regia* L.) where, at bloom, female flowers (nutlets) become necrotic and fall from the tree. Some cultivars are more susceptible to PFA than others, and there is also variation in the magnitude of PFA between years, and in different growing areas (Catlin and Olsson, 1990; Rovira and Aleta, 1997; Johnson and Polito, 2004). It affects fruit set and yield considerably (Catlin *et al.*, 1987). PFA can result in as much as 80% flower loss leading to reduction in yield by 20% in cv. Serr (Sibbett, 1998). Efforts are on to reduce PFA using ethylene inhibitors (Johnson and Polito, 2004; Reede, 2004). Since no definite causal factors have been identified to cause PFA, an attempt has been made in the present study to determine the effect of mode of pollination *i.e.*, under natural and artificial (hand and cross) pollination on pistillate flower abscission.

Materials and methods

Pistillate flower abscission was investigated on 18 -20 years old trees of 20 walnut accessions comprising of exotic cultivars and indigenous selections maintained in the walnut germplasm collection block of UHF, Nauni-Solan (HP) during 1999 and 2000. Twenty five flowers in each case on different branches were selected and subjected to different modes of pollination:

Natural (open)-pollination: Healthy female floral buds were counted and labelled on selected branches in each accession.

Self (hand) -pollination: Floral buds before anthesis were covered with muslin cloth bags and labelled. The bags were removed at the bifid stage of female flowers and already collected pollen from the same tree was dusted on the shining lobes of pistillate flower and again covered with muslin cloth bag to avoid contamination/injury.

Cross-pollination: In this case, the female floral buds were bagged and at bifid stage, the bags were removed and the fresh pollen of the male parents synchronizing in blooming time (Table 1) were dusted, rebagged and labelled.

Table 1. List of cultivars/selections used as male parents

Female parent	Male parent(s)
Exotic cultivars	
ACO 38853	Gobind, Plant No. 32, Xenia
Blackmore	Gobind, Xenia
Hartley	Gobind, Plant No. 32, Xenia
KX Giant	Plant No. 10, Rattan Akhrot, Kandaghat Selection
Lake English	Gobind, Xenia
Payne	ACO 38853, Blackmore, Plant No. 32, Xenia
Xenia	Gobind
Indigenous selections	
Gobind	ACO 38853, Blackmore, Plant No. 32, Xenia
Plant No. 10	Gobind, Plant No. 32, Xenia
Netar Akhrot	Roopa Akhrot, Kandaghat Selection, Inder Akhrot, Plant No. 45, Plant No. 47, Luxmi Akhrot
Roopa Akhrot	Plant No. 10, KX Giant, Rattan Akhrot, Kandaghat Selection, Plant No. 32, Plant No. 46
Rattan Akhrot	ACO 38853, Plant No. 32, Plant No. 46, Solding Selection
Kandaghat Selection	ACO 38853, Blackmore, Gobind, Plant No. 32, Xenia
Inder Akhrot	KX Giant, Rattan Akhrot, Plant No. 32, Solding Selection
Plant No. 32	Gobind, Xenia
Plant No. 45	Netar Akhrot, Roopa Akhrot, Plant No. 47
Plant No. 46	Gobind, Xenia
Plant No. 47	ACO 38853, Blackmore, Plant No. 45, Solding Selection
Solding Selection	ACO 38853, Gobind, KX Giant, Plant No. 32
Luxmi Akhrot	ACO 38853, Plant No. 32, KX Giant, Rattan Akhrot, Solding Selection

In addition to above, a set of 25 healthy flowers were bagged with muslin cloth and labelled before anthesis to record the extent of PFA in the absence of pollination. Per cent PFA was worked out by counting the number of dried (abscising) flowers in unpollinated flowers after two weeks of anthesis and after 30-35 days in pollinated flowers under each mode of pollination.

Results and discussion

Under unpollinated conditions in exotic cultivars in 1999 and 2000, 'Lake English' recorded maximum (100.00 and 94.33%, respectively) pistillate flower abscission whereas, 'KX Giant' exhibited minimum (0.00 and 5.33%, respectively). Similar trend was observed with both the cultivars under natural pollination. Under self-pollination, 'Xenia' recorded maximum (62.36 and 60.40%) pistillate flower abscission in 1999 and 2000, respectively whereas, no selfing could be done in cultivar 'Hartley', 'Lake English' and 'Payne' because of non-availability of pollen in the absence of development of catkins during the period of study. Other cultivars were significantly different from 'Xenia'. Under cross-pollination, 'Lake English' recorded maximum (100.00 and 96.66%) PFA in 1999 and 2000, respectively whereas, in 1999

Table 2. Per cent pistillate flower abscission in exotic walnut cultivars

Exotic cultivar	Unpollinated		Natural-pollination		Self-pollination		Cross-pollination	
	1999	2000	1999	2000	1999	2000	1999	2000
ACO 38853	17.03	21.73	51.56	56.09	19.60	18.31	27.43	30.50
	(24.35)	(27.77)	(45.90)	(48.50)	(26.25)	(25.33)	(31.37)	(33.52)
Blackmore	11.70	15.16	66.74	56.28	56.38	53.72	22.63	20.63
	(19.94)	(22.90)	(54.79)	(56.49)	(48.67)	(47.14)	(28.38)	(27.01)
Hartley	33.45	28.17	62.45	69.50	-	-	16.72	16.58
	(35.33)	(32.05)	(52.22)	(48.61)	-	-	(24.10)	(24.01)
KX Giant	0	5.33	28.37	34.62	24.68	30.53	23.45	27.58
	0	(13.31)	(32.17)	(36.04)	(29.78)	(33.54)	(28.95)	(31.67)
Lake English	100	94.33	100.00	97.66	-	-	100.00	96.67
	(90.00)	(76.19)	(90.00)	(81.19)	-	-	(90.00)	(79.45)
Payne	30.28	27.49	40.21	47.28	-	-	20.19	22.90
	(33.37)	(31.74)	(39.35)	(43.33)	-	-	(26.68)	(28.58)
Xenia	15.48	19.19	71.40	70.29	62.36	60.40	12.33	17.28
	(23.15)	(25.97)	(57.68)	(56.97)	(52.16)	(51.01	(20.51)	(24.55)
Mean	29.71	30.20	60.10	61.67	40.75	40.74	31.82	33.16
CD (*P*=0.05)	1.94	2.98	4.04	2.88	2.99	2.49	3.84	2.45

Figures in parentheses are *arc sine* transformed value

Table 3. Per cent pistillate flower abscission in indigenous walnut selections

indigenous cultivar	Unpollinated		Natural-pollination		Self-pollination		Cross-pollination	
	1999	2000	1999	2000	1999	2000	1999	2000
Gobind	30.38	31.33	60.27	58.33	24.99	22.33	31.45	32.28
	(33.44)	(34.04)	(50.93)	(49.80)	(29.99)	(28.19)	(34.11)	(34.62)
Plant No. 10	35.13	38.08	47.41	45.28	26.53	27.44	31.50	29.39
	(36.35)	(38.10)	(43.52)	(42.29)	(30.99)	(31.59)	(34.13)	(32.82)
Netar Akhrot	9.29	12.71	12.40	13.33	14.41	16.17	15.68	14.33
	(17.69)	(20.88)	(20.59)	(21.38)	(22.27)	(23.70)	(23.30)	(22.21)
Roopa Akhrot	38.54	35.11	19.37	22.39	18.17	16.33	30.18	28.36
	(38.37v	(36.34)	(26.09)	(28.24)	(25.21)	(23.81)	(33.32v	(32.17)
Rattan Akhrot	23.31	20.55	42.62	40.62	37.20	35.44	25.27	23.94
	(28.86)	(26.94)	(40.76)	(39.59)	(37.58)	(36.53)	(30.17)	(29.29)
Kandaghat Selection	24.44	27.00	24.40	25.07	12.70	11.66	35.41	33.16
	(29.61)	(31.30)	(29.59)	(30.04)	(20.83)	(19.95)	(36.51)	(35.16)
Inder Akhrot	18.42	21.11	35.52	34.22	8.47	9.11	15.13	13.50
	(25.40)	(27.34)	(36.58)	(35.80)	(16.88)	(17.55)	(22.36)	(21.54)
Plant No. 32	43.66	40.28	54.35	54.05	33.45	33.27	41.53	40.33
	(41.36)	(39.39)	(47.50)	(47.33)	(35.33)	(35.23)	(40.12)	(39.42)
Plant No. 45	21.16	24.00	25.19	27.44	12.42	14.22	13.28	23.17
	(27.37)	(29.32)	(30.12)	(31.59)	(20.59)	(22.13)	(21.32)	(22.39)
Plant No. 46	35.46	36.46	50.25	47.94	23.45	23.89	25.37	23.17
	(36.54)	(37.14)	(45.15)	(43.82)	(28.95)	(29.25)	(30.23)	(28.76)
Plant No. 47	28.44	30.00	12.49	13.22	12.51	15.00	15.56	16.61
	(32.22)	(33.20)	(20.66)	(21.30)	(20.69)	(22.76)	(23.21)	(24.03)
Solding Selection	17.42	18.44	57.23	57.66	33.30	31.61	20.51	18.33
	(24.64)	(25.41)	(49.16)	(49.41)	(35.24)	(34.21)	(26.92)	(25.34)
Luxmi Akhrot	50.33	52.50	40.16	42.51	16.55	15.44	22.48	21.61
	(45.19)	(46.43)	(39.32)	(40.69)	(23.97)	(23.13)	(28.29)	(27.69)
Mean	28.92	29.81	37.05	37.08	21.09	20.92	24.87	24.48
CD (*P*=0.05)	3.68	2.53	3.61	2.42	3.51	2.63	3.69	2.99

Figures in parentheses are *arc sine* transformed values

'Xenia' recorded minimum (12.33%) and in 2000 'Hartley' recorded minimum (16.58%) PFA which was significantly *at par* with 'Xenia' (17.28%) (Table 2).

Under unpollinated conditions in indigenous selections 'Luxmi Akhrot' recorded maximum (50.33 and 52.50%) pistillate flower abscission in 1999 and 2000, respectively whereas, minimum (9.29 and 12.71%, respectively) was recorded in 'Netar Akhrot'. 'Gobind' recorded maximum *i.e.* 60.27 and 58.33% pistillate flower abscission under natural pollination in 1999 and 2000, respectively which was significantly *at par* with 'Solding Selection' (57.23 and 57.66%, respectively) in both the years whereas, minimum PFA *i.e.* 12.40 per cent was recoded in 'Netar Akhrot' in 1999 and 13.28 per cent in 'Plant No.47' in 2000. Under self-pollination, 'Inder Akhrot' recorded minimum (8.47 and 9.11%) PFA in 1999 and 2000, respectively. Whereas, in 1999, 'Rattan Akhrot' recorded maximum (37.20%) and in 2000 also recorded maximum (35.44%) PFA, which was *at par* with 'Plant No. 32' (33.27%). 'Plant No. 32' showed maximum (41.53 and 40.33%) PFA in 1999 and 2000, respectively under cross pollination whereas, 'Plant No.45' recorded minimum (13.28%) PFA in 1999 and 'Inder Akhrot' (13.50%) in 2000 (Table 3).

Overall, natural pollination resulted in higher PFA in exotic cultivars and indigenous selections than under no pollination and self/cross-pollination. Since walnut is a wind-pollinated crop and most of the cultivars/selections differed in their blooming time, this could be either due to non-availability or excess of pollen (Por and Por, 1990; McGranahan *et al.*, 1994). Field-based research carried out for over thirty years by the scientists at University of California, Davis confirmed that PFA is always associated with high numbers of pollen grains present on the receptors (stigmas) of female flowers. Reduction of the pollen load in test orchards by catkin removal decreased PFA and increased yield. Research also showed that the excessive pollen tubes growing down the style of the female walnut flower produce excessive amounts of ethylene, a natural plant hormone associated with organ senescence. Recently, Retain®, a commercially available ethylene inhibitor developed by Valent Biosciences, tested on individual walnut fruiting shoots recorded a four-fold increase in set compared to untreated flowers (Reede, 2004). Various cultivars/selections included in the present study varied a lot for this trait recording as low as zero PFA in 'KX Giant' to as high as 100 per cent in 'Lake English' under unpollinated conditions suggesting further that PFA might be a varietal character, as contended earlier by many workers (Catlin *et al.*, 1987; Catlin and Olsson, 1990; Rovira and Aleta, 1997 and Rovira *et al.*, 2001).

From the above findings, it can be presumed that pistillate flower abscission is not wholly a varietal feature nor it is affected by mode of pollination. However, efforts may be made to interplant varieties with synchronizing blooming time to ensure optimum pollination so as to reduce abortion of pistillate flowers in walnut.

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